3

MULTISTAGE TRANSISTOR AMPLIFIER

- Multistage means more than one stage.
- Cascade arrangement – output of first stage is connected in series to the input of the second stage of same configuration.
- For this, coupling devices such as capacitor, transformer etc. are used. Capacitor helps to separate d.c. conditions of first stage from the second stage.
- If R and C are used for coupling, such amplifier is called RC coupled amplifier.
- If Transformer is used for coupling, such amplifier is called Transformer coupled.
- If Direct coupling is done, such amplifier is called Direct coupled.

RC coupled amplifier

We know capacitor blocks dc. It behaves as an 'open' to direct current.

(Capacitive reactance $X_C = \frac{1}{\omega c}$, $\omega = 2\pi f$, $f = 0$ for d.c. $\therefore X_C = \infty$).

Capacitor blocks d.c. So dc isolation is there, between the two stages. But it passes a.c. signal.

Fig. shows a two-stage RC – coupled amplifier. It consists of two single stage transistor amplifiers using CE configuration. The resistors R_C, R_1' and capacitor C_C form the **coupling network**. So it is called RC coupling. R_C is the collector load of Q_1 and R_C' is that of Q_2. R_1 and R_1' provide dc base bias.

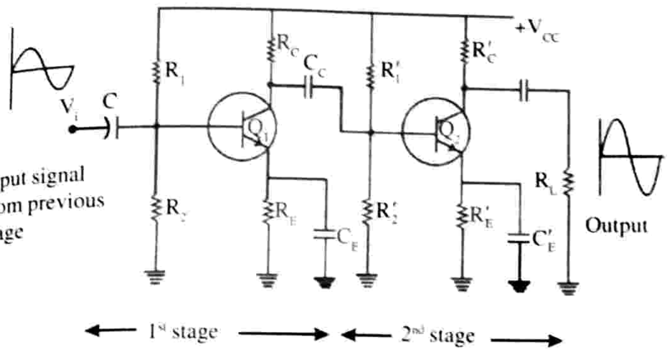

Fig. 3.1

Make each stage identical. When stage 2 is designed, the components of stage 1 are chosen as $R_1 = R_1'$, $R_2 = R_2'$, $R_C = R_C'$, $R_E = R_E'$, $C = C_C$ etc. C_C is calculated in terms of the input resistance to stage 2.

Voltage wave forms for a two stage CE circuit is as follows.

Input signal V_i is amplified by Q_1. Its phase is reversed. The amplified output of Q_1 appears across R_C. The output of first stage across R_C is coupled to the input of the second stage at R_1' by coupling capacitor C_C. The signal at the base of Q_2 is further amplified by Q_2. Its phase is further reversed. AC output of Q_2 appears across R_C'. The output across R_C' is coupled by another capacitor to load resistor R_L.

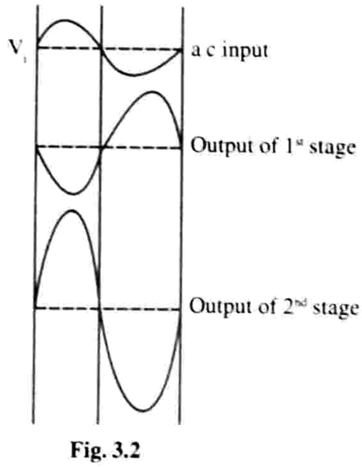

Fig. 3.2

The output signal is amplified twice. So it is exact a replica of the input signal. Output is also in phase with input signal.

The resistances R_1, R_2 and R_E form the biasing network. They also help for stabilisation.

C_E behaves as a short to a.c., signal. C_E keeps the emitter at a.c. ground. So for a.c. purposes R_E does not exist. If C_E is removed, the voltage gain of the amplifier reduces.

The total gain is less than the product of the gains of individual stages. It is because when a second stage is made to follow the first stage, the effective load resistance of first stage is reduced due to the shunting effect of the input resistance of second stage. This reduces voltage gain of the stage which is loaded by the next stage.

Frequency response of RC coupled amplifier

Fig. 3.3 shows the frequency response of an RC coupled amplifier. The voltage gain (Av) drops off at low frequencies (below 50Hz) and at high frequencies (above 20 kHz). It remains constant in the mid frequency range (50Hz to 20kHz).

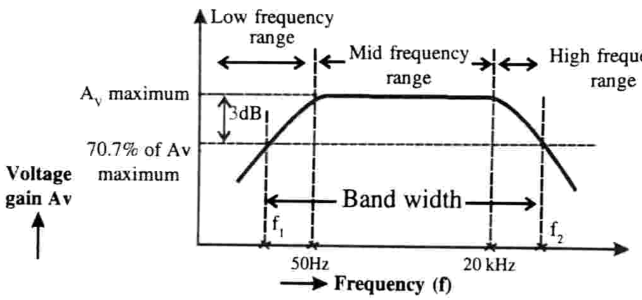

Fig. 3.3

i) at low frequencies

When frequency is very low (below 50Hz) the coupling capacitor C_C offers high reactance $\left(\because X_C = \frac{1}{2\pi fc}\right)$. So C_C will allow only a small part of the signal from one stage to other. At low frequencies the emitter capacitor C_E can not shunt the emitter resistance R_E. Because at low frequencies X_C is larger. Due to the above two factors, the voltage gain drops off at low frequencies.

ii) at high frequencies

When frequency is very high (above 20kHz) coupling capacitor C_C offers low reactance X_C. So it acts as a short circuit. So the loading effect of the next stage increases. This reduces the voltage gain

$\left(\because \text{voltage gain} = \frac{\text{output voltage}}{\text{input voltage}}\right)$. Also at high frequencies the capacitive reactance of base-emitter junction is low. Due to this base current increases. This reduces current amplification factor β. Due to the above two factors, the voltage gain drops off.

iii) At mid frequencies

At mid frequency range (from 50Hz to 20kHz) C_C maintains a constant voltage gain. This can be explained as follows.

When frequency increases, X_C of C_C decreases. This increases the gain. At the same time lower X_C increases the loading effect of first stage to which the gain reduces. These two factors cancel each other. So a constant voltage gain is obtained.

Band width

Bandwidth is the range of frequency over which gain is equal or greater than 70.7% of maximum gain.

In fig $\boxed{B.W = f_2 - f_1}$ H_z

f_1 is the lower cut off frequency and f_2 is the upper cut off frequency.

Problem

1. *Explain frequency response* *(CU Nov. 19)*

Advantages of RC coupled amplifier

i) It is small, light and inexpensive.

ii) It has a wide frequency response.

iii) It provides small frequency distortion.

iv) Overall amplification is higher.

Disadvantages of RC coupled Amplifier

i) Overall gain is small. This is due to the loading effect of the different stages.

ii) With age, it becomes noisy.

iii) Impedance matching is poor.

Its output impedance is several hundred ohms. But that of speaker is only few ohms. Due to this small amount of power will be transferred to the speaker.

Problem

2. *Draw the circuit diagram of a R-C coupled amplifier* *(CU Nov. 18)*

3. *The lower cut off frequency of an RC coupled amplifier is 40Hz. The bandwidth of amplifier is 300 kHz. Calculate the voltage gain at the lower cut-off frequency, if midband gain is 150.*

Ans : B.W $= f_2 - f_1$

upper cut off frequency $f_2 = B.W + f_1$

$= 300 + 0.04$

$= 300.04$ kHz

$$\left.\begin{array}{l}\text{Voltage gain at the}\\ \text{lower cut-off frequency}\end{array}\right\} = \frac{1}{\sqrt{2}} \times \text{mid band gain}$$

(or) $f_1 = 70.7\%$ of 150

$f_1 = 0.707 \times 150$

$= \mathbf{106.05}$

Voltage gain : (Av)

The ratio of output voltage (V_{out}) to the input voltage (V_{in}) of an amplifier is its voltage gain

$$A_V = \frac{V_{out}}{V_{in}}$$

4. *Explain voltage gain.* *(CU Nov.19)*

Note : Gain of a multistage amplifier is equal to the product of gains of individual stages.

$$Av = Av_1 \times Av_2 \times Av_3 \times ....$$

Decibel gain

To compare two powers, logarithmic scale is better than a linear scale.

The common logarithm (log to the base 10) of power gain is called bel power gain.

The unit is bel or decibel (db).

1 bel = 10 db.

$$\therefore \text{Power gain} = \log_{10} \frac{P_{out}}{P_{in}} \text{ bel}$$

decibel is a logarithmic measurement of the ratio of one power to another or one voltage to another.

Number of dB = 10 × Number of bels

Voltage gain in dB

$$\text{Power gain in dB} = 10 \log_{10}\left(\frac{P_{out}}{P_{in}}\right) \quad \text{--- (1)}$$

$$\text{But} \quad P = \frac{V^2}{Z} \quad \text{where } Z = \text{impedance}$$

Substituting in (1)

$$\therefore \quad dB = 10 \log_{10}\left[\frac{V_{out}^2 / Z_{out}}{V_{in}^2 / Z_{in}}\right]$$

$$= 2 \times 10 \log_{10}\left[\frac{V_{out}}{V_{in}}\sqrt{\frac{Z_{in}}{Z_{out}}}\right]$$

If $Z_{in} = Z_{out}$

Voltage gain in $\boxed{dB = 20\log_{10}\frac{V_{out}}{V_{in}}}$

$$A_{V_{dB}} = 20\log_{10} A_V$$

A_V is the voltage gain.

For ex. if $A_V = 100$, $dB = 20 \times \log_{10} 100$

$= 20 \times 2 = 40$

Note : For a multistage amplifier, the overall voltage gain is the sum of the decibel voltage gains of the individual stages.

If we express the gain in db, For a multistage amplifier, the overall gain is found as the sum of the gains of individual stages in dB.

Ex. For a two stage amplifier

$$\text{Gain } A_V = \frac{V_2}{V_1} \times \frac{V_3}{V_2}$$

$$\text{Gain in dB} = 20 \log_{10}\left(\frac{V_2}{V_1} \times \frac{V_3}{V_2}\right)$$

$$= 20 \log_{10}\frac{V_2}{V_1} + 20 \log_{10}\frac{V_3}{V_2}$$

= gain in db of 1^{st} stage + gain in db of 2^{nd} stage

Current gain in dB

$P = I^2R$

Sub in (1)

$$dB = 10 \log_{10}\left[\frac{I_{out}^2 R}{I_{in}^2 R}\right]$$

$$= 10 \log_{10}\left[\frac{I_{out}}{I_{in}}\right]^2 = 2 \times 10 \log_{10}\left[\frac{I_{out}}{I_{in}}\right]$$

Current gain in db $= 20 \log_{10}\frac{I_{out}}{I_{in}}$

Uses of decibel concept

There are some reasons for using logarithmic scale to denote voltage & power gain.

i) In this method, if there are a number of cascaded stages, the individual gains can be directly added.

ex. $Av_{dB} = Av_{1dB} + Av_{2dB} + ...$

ii) In many amplifiers, the output is in the from of sound. The response of human ear to sound is logarithmic. So logarithmic scale is most suitable for measuring relative intensity level of sound.

iii) Both very small and very large quantities of linear scale can be denoted.

Problems

5. *Find the decibel gain of voltage gain of 50.*

Ans : Voltage gain $= 20 \log_{10} 50$ db

$= 20 \times 1.6990$ db

$=$ **33.98** db

6. *Find the decibel gain of power gain of 160*

Ans : Power gain $= 10 \log_{10}160$ dB

$= 10 \times 2.2041$

$=$ **22.041** db

7. *The first stage voltage gain of a Two stage amplifier is 100 and its second stage voltage gain is 160. Find the total gain in db.*

Ans : **First stage**

Voltage gain in db $= 20 \log_{10}100$

$= 20 \times 2.0000 =$ **40**

Second stage

Voltage gain in db $= 20\ \log_{10}160$

$= 20 \times 2.2041 = \mathbf{44}$

Total voltage gain $= 40 + 44 = \mathbf{84}$**db**

8. *The voltage gain of an amplifier is 72. Find its gain in decibal.*

Ans : Power gain $= \dfrac{P_{out}}{P_{in}} = \left(\dfrac{V_{out}}{V_{in}}\right)^2$

Power gain in decibel $= 10\ \log_{10}\dfrac{P_{out}}{P_{in}}$ $(\because Z_{out}=Z_{in})$

$= 10\ \log_{10}\left(\dfrac{V_{out}}{V_{in}}\right)^2$

Voltage gain in decibel $= 20\ \log\dfrac{V_{out}}{V_{in}}$

$= 20\ \log 72$

$= 20 \times 1.8573 = 37$

$\therefore$ Gain $=$ **37db**

9. *A single stage amplifier has a voltage gain of 60. The collector load* $R_C = 500\Omega$ *and the input impedance is* $1k\Omega$. *Calculate the overall gain when two stages are cascaded through RC coupling.* *(CU Nov. 19)*

10. *An audio amplifier has an input resistance of* $100k\Omega$. *When a load of 5 ohms is connected across the output of the amplifier, a 0.5V (r.m.s.) input signal gives output equal to 5V (r.m.s.). Calculate power gain in dB.*

Ans : Voltage gain $= \dfrac{V_{out}}{V_{in}} = \dfrac{5}{0.5} = 10$

Power $= \dfrac{V^2}{R}$

Power gain in dB $= 10\ \log_{10}\dfrac{P_{out}}{P_{in}}$

$$= 10\log_{10}\left[\frac{\dfrac{V_{out}^2}{R_{out}}}{\dfrac{V_{in}^2}{R_{in}}}\right]$$

$$= 10\log_{10}\left[\left(\frac{V_{out}}{V_{in}}\right)^2 \times \frac{R_{in}}{R_{out}}\right]$$

$$= 10\log\left[\frac{V_{out}}{V_{in}}\right]^2 + 10\log\frac{R_{in}}{R_{out}}$$

$$= 2\times 10\log\frac{V_{out}}{V_{in}} + 10\log\frac{R_{in}}{R_{out}}$$

$$= 20\log\left(\frac{5}{0.5}\right) + 10\log\left(\frac{100\times 10^3\Omega}{5\Omega}\right)$$

$= 20 + 10\log 20000$

$= 20 + 10 \times 4.3 = \mathbf{63}$

11. *The maximum voltage gain in an amplifier is 1000. It occurs at 1kHz. It falls to 707 at 10kHz and 50 Hz. Find Bandwidth, Lower cut off frequency and upper cut off frequency.*

Ans :

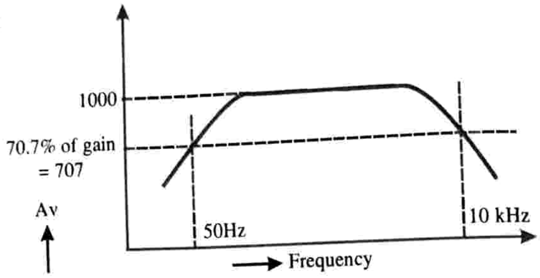

Fig. 3.4

$\therefore$ Bandwidth = 10000 – 50

= 9950 Hz = **9 95** kHz

Lower cut off frequency = 50 Hz

Upper cut off frequency = 10 kHz.

12. *The overall voltage gain of a two stage RC coupled amplifier is 80 dB. The voltage gain of the second stage is 150. Find the voltage gain of the first stage in dB.*

Ans :

$$Av_{dB} = Av_{1_{dB}} + Av_{2_{dB}}$$

$$80 = Av_{1_{dB}} + 20\log_{10}(150)$$

$$= Av_{1_{dB}} + 20 \times 2.1761$$

$$Av_{1_{dB}} = 80 - 43.52$$

$$= \mathbf{36.48} \text{ db}$$

13. *A three stage amplifier has a first stage of voltage gain of 100, second stage of voltage gain of 200 and the third stage voltage gain of 400. Find the total voltage gain in db* *(CU Nov. 18)*

Ans : For the first stage voltage gain in db

= 20 log 100 = 20 × 2 = 40 db

For the second stage, voltage gain in db

= 20 log 200 = 20 × 2.3 = 46 db

For the third stage, voltage gain in db

= 20 log 400 = 20 × 2.6 = 52 db

$\therefore$ Total voltage gain

$$= A_{V_1 dB} + A_{V_2 dB} + A_{V_3 dB}$$

= 40 + 46 + 52

= 138 db.

14. *An RC coupled amplifier has a voltage gain of 120 in the frequency range of 500Hz to 30kHz. On either side of these frequencies, the gain falls so that it reduced by 3dB at 100Hz and 50kHz. Calculate the gain in dB at cut-off frequencies and also plot the frequency response curve.* *(CU Nov. 2016).*

Ans :

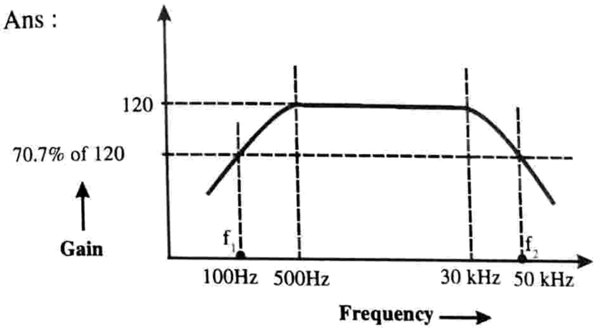

Fig. 3.5

$$\left.\begin{array}{l}\text{Voltage gain at the lower} \\ \text{cut off frequency (or) } A_V \text{ at } f_1\end{array}\right\} = \frac{1}{\sqrt{2}} \times \text{midband gain}$$

$$= 0.707 \times \frac{120}{2}$$

$$= 0.707 \times 60$$

$$= 42.42$$

$$\left.\begin{array}{l}\text{Voltage gain in dB at} \\ \text{cut off frequencies}\end{array}\right\} = 20 \log 42.42$$

$$= 20 \times 1.6276$$

$$= \mathbf{22.55\ dB}$$

Note : If dB gain falls by 3db, output power reduces to half

$\therefore$ dB gain reduces by half. (see page 92 Q. No. 11)

15. *A certain amplifier has voltage gain of 15dB. If the input signal voltage is 0.8V, what is the output voltage?* *(CU Nov. 19)*

Exercises

1. What is a R–C coupled amplifier?
2. Draw the circuit diagram of a two stage RC coupled amplifier. Clearly indicate the coupling elements.
3. In what ways a RC coupled amplifier differ from a single stage amplifier.
4. Sketch the frequency response curve drawn for an RC coupled amplifier.
5. What factors affect the voltage gain of the RC coupled amplifier at low frequencies and at high frequencies.
6. Explain frequency response of an amplifier.
7. Why the gain of RC coupled amplifier falls in both low frequency and high frequency ranges.
8. Define cut off frequencies.
9. Define Bandwidth of an amplifier.
10. While defining the cut-off frequencies of an amplifier, why do we take 70.7% of the mid band gain?

    Ans : If voltage gain falls to 70.7% of maximum gain, human ear (which is not a very sensitive hearing device) can not detect the change. For example, if gain = 100 fall to 70.7, our ears can not detect the change in gain. If the voltage gain falls

below 70.7, our ears will detect the change. Bandwidth is the range of frequency (over which gain is equal to or greater than 70.7% of maximum gain) over which the gain will appear constant to human ear.

11. Why the lower and upper cut off frequency are called half-power frequencies?

    Ans : If the power output of an amplifier is reduced to half, its db gain falls by 3db.

$$\text{Fall in power gain} = 10 \log_{10}\left(\frac{\frac{P}{2}}{P}\right)$$

$$= 10 \log_{10}\left(\frac{1}{2}\right)$$

$$= -10 \log_{10}(2)$$

$$= \mathbf{-3\ db}$$

These frequencies are called 3db frequencies or half-power frequencies.

12. More stages are cascaded to obtain high gain. Does the bandwidth of the multistage amplifier remains the same as that of the individual stages ? If not, why?
13. Why RC coupling is employed in the initial stages of a multistage amplifier?

    Ans : Initial stage performs the job of voltage amplification. Final stage delivers maximum power to the output device (ex. Load speaker). (In the output impedance matching is required).
14. Total gain of the multistage amplifier is less than the product of the gains of individual stages. Why is it so?

Ans : This is due to the loading effect of next stages. For example consider two amplifier each has a stage gain of 50. When these two are coupled, the total gain will be less than 50 x 50 = 2500.

This is because the gain of first stage will be less than 50 due to the loading effect of input impedance of second stage. But the gain of 2nd stage will remain 50. Because there has no loading effect of any subsequent stage.

15. The cut off frequencies in an amplifier is also called as 3db frequency. Why?

Ans : The voltage gain at cut off frequencies is 3db below the maximum gain. For example, consider an amplifier of maximum voltage gain 80. Then 70.7% of 80 is 56.56.

Fall in voltage gain from maximum gain

$$= 20 \log_{10} \frac{80}{56.56} \text{dB}$$

$$= 20 \log_{10} 1.414 \text{dB}$$

$$= \mathbf{3\ db}$$

16. 'We prefer expressing the gain of an amplifier in 'dB' rather than absolute values.' Why?

Transformer coupled Amplifiers

Here transformer is used to ac - couple the different amplifier stages. DC isolation between two stages is provided by the transformer itself. The resistance of the windings of transformer is very small. So there will not be any effect on the transistor bias conditions. The dc voltage drop across the primary coil of the transformer is negligible. So all of the dc voltage is applied at collector. The power loss across R_L is negligible. Transformer coupling is preferred for power amplifiers (especially when signal frequency is > 20kHz).

Advantage

This method is more *efficient*. This is because of low dc resistance of the primary connected in the collector circuit. It provides a *higher voltage gain*. No signal power is lost in the collector or base resistors.

The input impedance of CE amplifier is of the order of 1kΩ while the output impedance is of the order of 15kΩ. Due to this mismatch of impedance, a significant loss in gain may result. But by using transformer coupling this mismatch can be avoided. Between two stages *impedance matching* is possible. This helps for maximum power transfer.

Disadvantage

It is costly and bulky. It has poor frequency response. Noise or 'hum' may be in the output. At RF (Radio frequencies), inductance and winding capacitance may produce some problems.

DC load is zero. But ac load $R_L' = n^2 R_L$ where $n = \frac{n_p}{n_s}$, turn ratio of transformer. The inductance due to primary and secondary coil is also to be considered. Interwinding capacitor also may takeplace. So some time a.c. load is a complex one and called reflected impedance. Because of this at high frequencies (RF), various elements are reflected towards primary of the transformer from the secondary side.

Fig. shows a two stage transformer coupled amplifier. Transformer coupling is used when load is small. Coupling transformer is used to feed the output of first stage to the input of second stage. Then primary (p) of this works as collector load. its secondary gives input to the second stage.

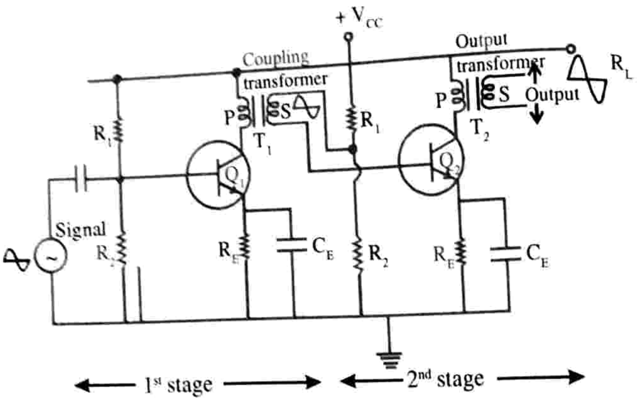

Fig. 3.6

Working

An a.c. signal is applied to the base of Q_1. This signal appears in the amplified form across primary of the coupling transformer T_1. This voltage is transformed to the secondary S and it is fed to the input of 2nd stage. Second stage again amplifies it more.

Frequency response of transformer coupled amplifier

Frequency response is comparatively poor. Gain is constant only over a very small range of frequencies. Gain increases in the high frequency range. The peak value changes with Q value of circuit. The frequency (f_r) at which peak occurs represents the resonant frequency.

Transformer coupled amplifier shows frequency distortion.

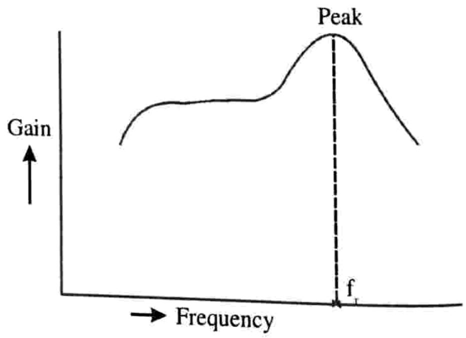

Fig. 3.7

Applications

Transformer coupling is used in the last stage of multistage amplifier. Here effort is made to maximise power transfer by perfect impedance matching.

Problems

16. *How will you get frequency response comparable to RC coupling in a transformer coupling?* *(CU Nov. 19)*

17. *In a transformer coupled amplifier the load connected to secondary coil is $10k\Omega$. If the turn ratio of transformer is 2:1, find the a.c. load faced by amplifier.*

Ans :

$$R'_L = \left(\frac{n_p}{n_s}\right)^2 R_L \qquad n_s : n_p = 2:1$$

$$10\times10^3 = \left(\frac{1}{2}\right)^2 R_L$$

$$R_L = 4\times10^4 = \mathbf{40k\Omega}$$

18. *In the final stage of a multistage amplifier, transformer coupling is used. The output impedance of transister is $1k\Omega$. The speaker has a resistance of 8Ω. Find the turn ratio of the transformer if maximum power is transformed to the load speaker.*

Ans :

$$R'_L = \left(\frac{n_p}{n_s}\right)^2 R_L$$

$$1\times10^3 = \left(\frac{n_p}{n_s}\right)^2 \times 8$$

$$\left(\frac{n_p}{n_s}\right)^2 = \frac{10^3}{8} = 125$$

$$\frac{n_p}{n_s} = \mathbf{11.18}$$

19. An 8Ω speaker is to be matched with an amplifier so that the effective load resistance is 0.8kΩ. Find the transformer turns ratio.

$$R'_L = \left(\frac{n_p}{n_s}\right)^2 R_L$$

$$\left(\frac{n_p}{n_s}\right)^2 = \frac{R'_L}{R_L} = \frac{0.8\times10^3}{8} = 10^2$$

$$\frac{n_p}{n_s} = \mathbf{10}$$

Exercises

17. Explain how impedance matching is provided with a step-down transformer in a transformer coupled amplifier.

Ans : The last stage of a multistage amplifier is the power stage, i.e., power is delivered to the loud speaker. To give maximum power to the speaker, the speaker impedance must be equal to the output impedance of the amplifier. This can be realized by using a step down transformer.

Turn ratio of transformer (step down ratio)

$$n = \frac{n_p}{n_s}$$

R_L is the load resistance connected to secondary. The load appearing on primary side,

$$R'_L = \left(\frac{n_p}{n_s}\right)^2 R_L.$$

By adjusting the value of $n = \frac{n_p}{n_s}$, the value of R'_L can be adjusted and made equal to the output resistance (impedance) of the amplifier.

18. When do we require multistage amplifier?

Direct – Coupled Amplifier : (D.C. amplifier) (CU Nov. 2016, 17)

To amplify signals having low-frequency which is lesser than 10Hz or to amplify direct current (which has zero frequency) (ex. photo electric current & thermo couple current), Direct coupled amplifiers are used.

A three-stage direct-coupled amplifier is as shown in fig. In fig, first stage uses **npn** and the second stage uses **pnp** etc.

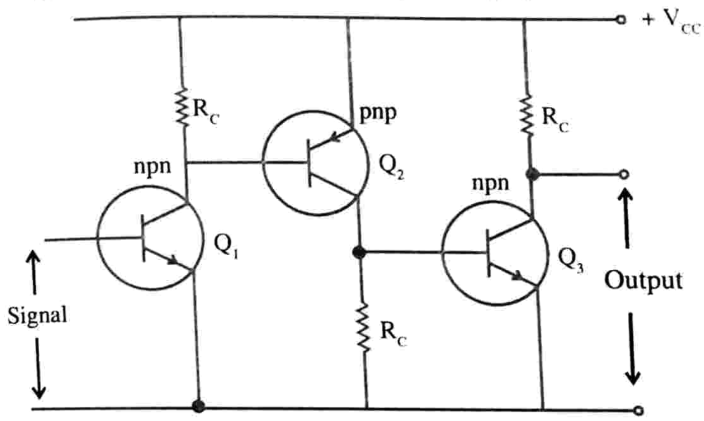

Fig. 3.8

Signal is given to the input of Q_1. The amplified output of the 1st stage is obtained across R_C of Q_1. This voltage drives the base of Q_2 and so on.

Advantages (CU Nov. 2016)

i) Minimum number of resistors are used.

ii) No coupling devices. So low cost

Disadvantages

i) For high frequencies DC amplifier can not be used.

ii) When temperature changes, operating point changes.

19. R.C. coupled or transformer coupled amplifiers are not used fo very low frequency range below 10Hz. why?

Ans : Their size at such low frequencies become quite bulky.

20. Compare RC, Transformer & Direct coupling amplifiers in terms of frequency response, cost, space and weight, impedance matching and use.

Ans :

Table 3.1

	RC	Transformer	Direct
1. Frequency response	In AF range excellent	Poor	Best
2. Cost value	Less	Large	Least value
3. Space needed	Very small	Large	Least
4. Weight	Very small	Large	Least
5. Impedance matching	Poor	Excellent	Good
6. Use	For Amplifying voltage	For amplifying power	For amplifying < 10Hz frequency

Note : The coupling capacitor Cc limits an amplifier's lower 3dB frequency.

21. What will happen if R_E is left unbypassed?

Ans :i) It will provide a path for negative feedback.

ii) It will result in reducing the voltage gain.

Note : In case of multistage amplifier, the B.W. is less than that of single stage.

22. Why R.C. coupling is the widely used coupling between the two stages of cascaded amplifier? (CU Nov. 2015)

Ans :i) It has a wide frequency response. The gain is constant over the audio frequency range which is the region of most importance for speech, music etc.

ii) Its overall amplification is higher than that of the other couplings.

iii) It requires cheap components like resistors & capacitors. It is small, light and inexpensive.

iv) It provides less frequency distortion.

Assignments

1. Draw the circuit diagram for a CE transistor amplifier.
2. Two transistors in CE are cascaded. What does the load on first stage consist of? What is the effect of this on the voltage gain of the first stage?
3. Draw the frequency response curve of an R-C coupled amplifier.
4. Why does the gain falls in the lower and upper frequency range of an amplifier?
5. "We prefer expressing the gain of an amplifier in dB rather than absolute values." Explain.
6. Draw the circuit diagram of Direct coupled (D.C.) amplifier.
7. A single stage CE amplifier has a gain of 60. $R_C = 500\Omega$. $R_i = 1k\Omega$. Calculate the overall absolute gain and Gain in dB when such two stages are coupled through R-C coupling.

   (Ans: 2397, 65.5dB)
8. In a CE transistor amplifier midfrequency gain is 200. It falls to 141.4 at 50Hz and also at 10kHz. Calculate the (-3) dB frequencies and Bandwidth of the amplifier.

   [Ans: Lower 3dB frequency 50Hz,
   Upper 3dB frequency 10kHz
   Band width 9950 Hz.]
9. The voltage gain of a two stage amplifier is 100dB. If the voltage gain of second stage is 100, calculate the voltage gain of first stage in absolute value and in dB

   (Ans: 1000, 60dB)
10. The voltage gain of a multistage R-C amplifier is 65dB. If the input voltage to the first stage is 0.5mV, calculate the output voltage.

    (Ans: 0.89V]
11. What is the overall voltage gain when two or more stages of an amplifier are cascaded?

12. In an CE amplifier, if R_E is unbypassed, what happens?

    Ans: It will provide a path for negative feedback and voltage gain will reduce.

13. What happens to the Bandwidth of multistage amplifier in comparison with single stage?

    Ans: Bandwidth becomes less for multistage.

14. Why transformer coupled amplifier is having a vertical d.c. load line?

    Ans: The resistance of primary coil of transformer is very small and nearly equal to zero. So slope becomes 90°.

15. Two identical R-C coupled amplifier stages are coupled. For each stage, the mid frequency gain is 10. What is the overall gain in decibel?

    Ans: 40dB

16. Give the order of bypass capacitor value in CE amplifier?

    Ans: 50μF electrolytic capacitor.

17. What is the effect of input impedance of a stage on the preceding stage of a multistage amplifier?

    Ans: This acts as a load resistance. This loads down the signal appearing at the input of second stage. Due to this the ac voltage appearing between base and ground decreases.

18. What is the use of capacitors in multistage amplifiers?

    Ans: Capacitors are open to d.c. and short to a.c. They are either used as coupling capacitors or bypassing capacitors. Coupling capacitors are connected between two succeeding stages or between the load and collector of the final stage. They do not allow dc level to shift in succeeding stage. So maximum signal appears at the output.

19. Three identical amplifiers each of gain 50, input resistance 1kΩ and output resistance 250Ω are cascaded. Calculate the open circuit voltage gain in dB of the system.

    Ans: 102 dB.